DEPARTMENT OF EDUCATION AND SCIENCE

ENGINEERING IN POLYTECHNICS

A report on HMI visits to 13 polytechnic engineering departments

REFERENCE ONLY
THIS BOOK MAY NOT BE
TAKEN OUT OF THE LIBRARY

SOUTHAMPTON UNIVERSITY LIBRARY

LONDON: HER MAJESTY'S STATIONERY OFFICE

© Crown copyright 1984

First published 1984
ISBN 011 270396 8

Contents **Page**

1 Introduction

1.1 Background 5
1.2 Present range and scale of engineering in polytechnics 5
1.3 Overall provision of each polytechnic 6

2 Engineering provision

2.1 Courses 7
2.2 Industrial training placements 9
2.3 Student backgrounds 10
2.4 Student attitudes 12
2.5 Student experiences 13
2.6 Teaching and learning 14

3 Resources

3.1 Accommodation 17
3.2 Equipment 18
3.3 Staff 19

4 Summary 21

Appendix I Titles and modes of first degrees and diplomas in the higher education inspected 24

Tables

Table 1 Comparative engineering degree course enrolments for 1981—82 in universities and polytechnics in the UK. 26

Table 2 Polytechnic engineering enrolments (October 1981) — national enrolments by subject group, level and mode of study. 27

Table 3 Polytechnic engineering enrolments (October 1981) — overall degree, postgraduate and sub-degree enrolments of polytechnics in England and Wales. 28

Table 4 Principal subject group enrolments at each polytechnic — by level and mode, with first degree and higher degree/postgraduate combined. 30

1 Introduction

1.1 Background

The first of the 30 polytechnics in England and Wales were designated in 1966; 29 of these now provide engineering courses. The work initially inherited by these polytechnics was mostly at the advanced level and included full-time and sandwich first degree and Higher National Diploma (HND), part-time Higher National Certificate (HNC), City and Guilds of London Institute (CGLI) technician and craft courses. There were few part-time degree courses and very little postgraduate and research work. Some polytechnics had developed prior to their designation a range of strong, long standing first degree and HND courses but others were less fortunate and had only work of a sub-degree level.

The 1966 White Paper *A plan for polytechnics and other colleges* Cmnd 3006 required that polytechnics should develop so as to be comparable with, but distinct from, universities. It was the intention that the polytechnics, while covering courses corresponding in level to those in universities, would continue to offer the range of established full-time and part-time sub-degree courses hitherto associated with these major establishments in the public sector. It was expected that the polytechnics would be primarily teaching institutions.

1.2 Present scale and range of engineering in polytechnics

A comparison between university and polytechnic total engineering degree course enrolments is indicated in Table I. It should be noted that the figures in this table refer to the entire United Kingdom whereas later tables relate to England and Wales alone. From Table 1 it will be seen that on average, polytechnics account for about one-third of all engineering degree course students. It can also be observed that on average higher and postgraduate enrolments represent 13.7 per cent of all university engineering degree enrolments while the corresponding figure for polytechnics is 3.4 per cent.

Table 2 indicates the range of engineering broad subject areas described by portmanteau titles which may cover several distinct areas of study. Electrical engineering, for example, includes power generation, machines, electronics and communication engineering; general and other engineering describes control, instrumentation and systems, and may include links with a non-technological subject, for example, business studies, while mechanical engineering embraces dynamics, engineering design, fluids, stress analysis, properties of materials and thermodynamics. A course in any of the main subject areas is generally based broadly on all or most of the constituent disciplines with opportunities provided for specialisation, as the course progresses, through a suitable option system.

Table 2 describes the situation in October 1981 in terms of the levels of courses available nationally and the corresponding enrolment patterns in all subject areas and modes of study. It can be seen that a total of 27,394 students were then enrolled in engineering courses in Polytechnics, of whom 14,335 were undergraduates, including a small number of Dip HE students. Apart from a small number (1369) of part-time students, the undergraduates were following full-time or sandwich modes of study. Postgraduate students totalled 588 with a clear emphasis (505) on a part-time mode of attendance. Students enrolled in sub-degree courses numbered 12,471 with the part-time students marginally in excess of those following full-time or sandwich modes of study. Part-time students amounted to 31 per cent of all engineering students enrolled in polytechnics at that time.

Not surprisingly, the principal subject areas, electrical, mechanical and civil engineering attracted the greatest support from students and these subjects are available in most polytechnics. By contrast the more specifically directed subjects fuel technology, chemical engineering, marine engineering, and naval architecture attracted few students nationally but these courses are concentrated in a small number of polytechnics whose geographical or historical associations justify their continuation as a resource for and provider of these minority disciplines.

1.3 Overall provision of each polytechnic

Table 3 describes the level of activity in October 1981, in terms of enrolments, in postgraduate, undergraduate and sub-degree courses in each polytechnic. The table orders the polytechnics by the total number of degree and postgraduate enrolments. It highlights in a dramatic way the very wide range of such enrolments from 1176 to 99 and it shows that the undergraduate/postgraduate enrolments as a percentage of all engineering enrolments in the polytechnics varies from 85 down to 10.

From information available it would seem that, while there is a corresponding degree of variation in size of undergraduate engineering provision among the universities, the average would be as large as that in the larger polytechnics recorded in Table 3.

The provision of degree courses by part-time study is not uniform over the polytechnic sector, but polytechnics are responding to this increasing demand from mature students in so far as their own resources and internal academic development policies allow.

Table 3 shows a considerable variation in the level of postgraduate activity. The healthy prosecution of first degree work depends to a large extent on a high level of scholarly activity on the part of the associated teaching staff. It is disturbing, therefore, to note that in some centres where undergraduate provision is significant in size there is little or no postgraduate work alongside.

Most polytechnics would claim that sub-degree courses — full-time and part-time — were an essential and desirable sector of their total provision. Nevertheless, relative to undergraduate enrolments, there is a wide range of activity in this area. At one extreme one polytechnic has no full-time or sandwich sub-degree involvement in spite of its large undergraduate enrolment. In general, however, it can be assumed that the level of commitment in the sub-degree field reflects resource constraints and/or LEA or RAC policy decisions where the resources of nearby FE colleges are a factor which must be taken into account in deciding the distribution of courses in the area.

Finally, Table 4 gives a more detailed statistical picture of engineering programmes in each polytechnic. From this the 'average' polytechnic has a total of 920 students with an enrolment profile of 20 postgraduates (mostly part-time), 500 undergraduates and 400 sub-degree students.

2 Engineering provision

2.1 Courses

The 13 polytechnic engineering departments inspected represented, in size and variety of work the spectra covered by Tables 2 and 3. The 30 undergraduate courses in the departments were in four categories — 13 electrical engineering, 7 general and other engineering courses, 9 mechanical engineering and 1 part-time production engineering course. Details are given in Appendix I.

Two of the 13 engineering departments inspected, both in the same Polytechnic, were running higher degree or postgraduate courses, ie., three Master of Science courses, two in part-time and one in full-time modes. Additionally a two term, full-time, Polytechnic Diploma course was offered for MSC sponsored students under the Training Opportunities Scheme and shared some common studies with the full-time MSc course. Individual units of the part-time MSc courses were also available to suitably qualified and experienced engineers and technicians who did not wish to enrol for the whole course but wished to select components of the course to suit their particular needs.

Over 50 part-time and full-time sub-degree courses were inspected covering the range of awards outlined in the Preface. No full-time or sandwich TEC Higher award programmes were seen during the inspections.

Fifteen of the 30 degree courses inspected led to both unclassified and honours degrees, 4 to the honours degree alone and 11 to unclassified degrees. It was unusual for a department to offer both full-time and sandwich degree courses but there is now an increasing tendency for both modes to be offered in response to the decline in industrial placements for sandwich students. Part-time courses are generally offered alongside full-time or sandwich courses and usually lead to unclassified degrees. In a small number of cases the part-time degrees are not supported by full-time or sandwich degrees in the same discipline and, in engineering, HMI regards this as an unfortunate academic development which is also wasteful of resources. Mixed discipline courses such as engineering with business studies may involved the close cooperation of as many as six departments within a polytechnic. It appeared that such courses were less sought after by students than single discipline engineering courses and students were liable to encounter serious industrial placement problems. The reluctance of some professional institutions to accredit such courses may act as a further discouragement of potential student enrolment. Honours and unclassified routes in a single discipline are often common for the first two academic years then divide into separate groups for the final years. In one polytechnic this was avoided by 'tariff arrangements' in which, after the first year, each subject is offered at 2 levels so that there is economic provision throughout the course without separate honours and unclassified streams.

In most polytechnics a range of final year specialist options is offered but the extent to which they are available in practice depends upon the group size achieved being in accordance with minimum DES requirements. Particular combinations of options, for example, aeronautical, production, industrial or marine engineering options in a mechanical engineering course, may provide for special interests. Again in electrical and electronic engineering courses the final year options may permit strong biases towards such areas as communications engineering, electrical power engineering, computer or systems engineering. In general students favour the options in courses which venture towards the newer fields of technology.

The length of the academic element of full-time and sandwich courses varies from nine term, 90 week courses to about 120 weeks in ten terms, the full-time courses covering three academic years and the sandwich courses four. Sandwich courses follow a variety of patterns but all are organised to provide at least 48 weeks of supervised industrial training during the four years. In a typical 'thin' sandwich course in the first 3 years students attend college for periods of 22 to 24 weeks and spend the remainder of the time each year in industry. They then attend full-time for their final year. In a typical 'thick' sandwich course, students are in industry for a whole year between the second and third years of their academic study.

Many thin sandwich courses are now being converted into thick sandwich courses partly because they may be more easily changed into the full-time mode in the event of the failure to secure industrial placements and also because some industries prefer the longer training period.

Part-time degree courses normally occupy four years of day and evening attendance for about 10 hours per week and are designed for students entering with a good HNC and at least four years of relevant industrial experience. Where offered, the honours level of part-time courses usually entails an extra year of study. In some cases the part-time courses can be attended over a longer period to suit the requirements of the student.

The two Dip HE courses inspected were arranged to be largely common with the earlier years of the degree courses, but in one case this led to some detrimental defects in the curriculum design of the degree course. The content of Dip HE courses appeared to correspond to about two-thirds of that of an unclassified degree.

2.2 Industrial training placements

Because of the difficulties in obtaining basic engineering workshop practice in industry, most unsponsored and many sponsored sandwich students, before proceeding into industry, now spend a 12 week period in the workshop of the polytechnic or a local college. This period may correspond to the Engineering and Shipbuilding Industry Training Board (ESBITB) training module EP1 and also be recognised by professional institutions. In some cases this training period is included within the 'approved' length of the course but in others it is not. Mandatory or discretionary grants are normally paid to students for this 12 week workshop period. During the industrial training period the student is visited often twice by a member of staff allowing the training programme and the student's progress to be monitored and any problems resolved.

Satisfactory completion of industrial training is a condition of the award of both the sandwich degree and HND at the end of the courses. In addition a polytechnic certificate of industrial training may be awarded. Exceptionally, if industrial training is incomplete a full-time degree is granted in place of a sandwich degree. For the same reason Joint Committees are making concessions to HND students. It is rare for the industrial training to contribute towards the determination of the overall classification of the degree.

Difficulties in finding industrial training places for sandwich students are affecting all courses particularly HND. The problems have become so acute that even well established arrangements, where much planning and effort has been invested and much industrial goodwill has been built up, are suffering badly and many departments are forced to question the future of their sandwich courses.

2.3 Student backgrounds

Enrolment patterns in undergraduate full-time and sandwich courses tend to indicate a North/South polarization. Students in the north of England generally enrol upon courses in the northern polytechnics while students below the Wash mostly attend engineering courses in the south. Students are usually 18 or 19 years of age at entry although those with non-GCE A-level entry qualifications or from overseas are often older. There are disappointingly few female engineering students in polytechnics and the number of students from overseas is reducing.

A large proportion of polytechnic engineering undergraduates had initially applied for university places but had been rejected. Students normally gain entry to polytechnic engineering first degree courses with A-levels in mathematics and physics. Excluding enhanced four year courses, one of which has an 11 point entry, the average A-level point score for polytechnic engineering degree courses entry is between 4 and 5. One course inspected enjoyed an average of nearly 9 points while another accepted students with as few as 2 points not necessarily in either mathematics and physics. As the number of applications has risen over recent years there has been a tendency for average A-level point scores to increase slightly, usually in disciplines involving electronics. The point score has fallen in a few of the more traditional courses. The number of students qualified for entry with OND and TEC awards was increasing although some departments still looked upon TEC awards with some misgivings. Entry qualifications gained by part-time study were rare.

Virtually no full-time undergraduate students are sponsored by industry. Generally less than a third of sandwich students are sponsored at entry to their courses but this proportion rises during the course as they become known in industry and are offered and accept sponsorship by employers with a view to permanent employment.

Students are most often admitted to part-time first degree courses with HNC or HND qualifications and may travel up to 100 miles each week to attend the polytechnic. They are generally mature senior technicians or teachers seeking degree qualification and aspiring to Chartered Engineer status. It is unlikely that support for these courses will continue at a viable level when the Institutions raise their requirements for corporate membership to an honours degree instead of an unclassified degree. For many the target will be too difficult or the extra year required too daunting a prospect. Students expressed concern that these changes might invalidate for membership purposes the degree for which they had been striving so long and hard to obtain.

Entry to MSc courses generally requires an honours degree qualification or a suitable alternative and relevant and acceptable industrial experience. Because of the varied range of previous knowledge and qualifications of MSc students, preliminary courses are also available and are taken by many during the term or vacation preceding the start of the course.

The students seen on the full-time MSc courses ranged from young graduates to mature practicing engineers with qualifications ranging from HNC to MSc. MSc students from the United Kingdom were on Science and Engineering Research Council (SERC) grants or industrial scholarships although many full-time MSc students were from overseas.

Like students on part-time first degrees those on part-time MSc courses are generally a mixture of mature engineers or senior technicians from industry and teachers from FE colleges. However, on the course seen all students were on day release from industry some having had to make up the time to their employers. Their motivation was broadly career enhancement and/or personal development. Students travelled to the course from distances up to 60 miles.

HND students have similar backgrounds to the full-time and sandwich degree students but have lower academic attainments at entry.

The part-time students attending Technician Education Council Higher Certificate (TEC-HC), HNC and CGLI courses are normally from a catchment area extending from the local to the sub-regional. Occasionally are they from further afield as when, for example, a

SOUTHAMPTON LIBRARY UNIVERS

national employer uses a block release programme provided by a particular polytechnic. TEC-HC students are already employed in engineering, usually with two or three years of training and experience behind them. Most left school at 16 or 17 years of age and have attended day release courses, first in colleges of FE and then in a polytechnic.

Where the polytechnic is not the only provider of higher technician courses in the locality it would seem that only a minority of students, preferring the better facilities and prestige, choose to attend the polytechnic. Most prefer to remain in the feeder colleges where this work and their presence are highly regarded. As financial restrictions continue to limit both teaching and material resources there is a possibility that some polytechnic engineering departments will decide to concentrate their efforts upon undergraduate work and will abandon part-time and technician work to other colleges already competing at this level. These are further factors contributing to the departure of the polytechnics from the White Paper concept.

Students attending engineering short courses at the polytechnics have a wide variety of backgrounds depending on the type of course and the target population for which it was designed. Generally short course students are employed in engineering as technicians, engineers or managers. They are only rarely from beyond the local or sub-regional area around the polytechnic.

2.4 Student attitudes

Students were always willing to talk about their aims, experiences, attitudes and aspirations. Students on full-time and sandwich degree courses usually have a strong engineering orientation and tend to see themselves as young engineers in training rather than simply students. Their dedication and motivation were evident and in the main there was an impressive sense of purpose which was displayed by positive attitudes to laboratory and project work. Many students admitted deep disappointment at not obtaining a university place, but soon found the polytechnic course satisfying, interesting and intellectually challenging. They needed to work hard to keep up with the demands of the course. Dip HE students viewed the award as a fall-back qualification should they not obtain a degree.

Part-time degree students were exceptionally dedicated and industrious and their maturity and work experience helped their studies enormously. Courses were extremely demanding both at college and during home study. Nevertheless with application by the students plus guidance and encouragement from the staff, wastage was low and normally confined to the first year.

Many HND students had originally applied for admission to a degree course but had failed to meet the A-level entry requirements. The HND course however still provides an opportunity for transfer to a degree course at a later stage and some HND students do, in fact, perform sufficiently well in the first year to achieve their original ambition.

2.5 Student experiences

Most students spoke of their satisfaction with courses and their appreciation of the helpful attitudes of teachers and tutors. Generally it was felt that the teaching was good and students accepted the frequent passive learning situations. They valued in particular the highly demanding project work and found it the most interesting and useful part of their learning experience. Occasionally the content of courses was criticised by students where it was out of date or not appropriate to their needs. A few staff were criticised for using the same notes they took down themselves when undergraduates. In some departments students were dissatisfied with the physical resources provided. This occurred when computer facilities were found inadequate or unavailable when needed, when private study facilities were non-existent or too remote and when split sites produced travel problems and time wasting journeys. It was noticeable that where the general resources and environment of the polytechnic were good, students were appreciative and their work benefited.

TEC-HC students claimed that laboratory work had been largely or completely lacking from their previous TEC-Certificate courses, but phase testing was very frequent. They welcomed more time being devoted to laboratory work and less to phase testing in their present courses. However, they often found that a faster pace was expected than they were used to, and the teaching styles different, requiring more individual study on the part of the student. Some students were having difficulties which seemed to stem from problems caused by gaps in knowledge of scientific principles or mathematics. Their difficulties seemed to be greatest where low enrolments in the feeder college had resulted in the combination of 'academic' and 'practical' streams for some units. Where students, having studied to TC or TD level in different colleges, were now on common TEC-HC programmes there were often serious mismatch problems.

At the time of the inspections students had few worries about getting jobs at the end of their courses as employment prospects for graduate engineers and HND holders were then good. However, the problems of industrial placement and the likelihood of poor quality work experience worried many students on those sandwich courses encountering serious placement problems. Students rarely made good use of the library especially if it was remote from the teaching site. Full-time students took a full part in the corporate life of the colleges but understandably few part-time students wished to participate.

2.6 Teaching and learning

Generally the teaching seen was conscientious, adequate and competent but often of a very traditional expository style centred on chalk board work and usually involving extensive and tedious note taking by students. This situation was partially attributable to the fact that teaching rooms were frequently remote from laboratories and lacked the storage, power supplies and services needed for demonstrations. This was aggravated by classrooms seldom being dedicated to the teaching of a particular specialist subject but considered part of the general teaching accommodation of the polytechnic. Very often staff faced extreme difficulties in getting demonstration equipment into classrooms either because of the need to climb flights of stairs or because of the remoteness of hutted classrooms. There were a few notable exceptions where engineering departments were housed in modern purpose built accommodation.

Growth in enrolments and pressure to raise class sizes often inappropriate to the available seating capacities of the teaching rooms sometimes had resulted in overcrowded conditions for students and insufficient circulation space for teachers. Too often many students not only had inadequate space to write but had difficulty in hearing and seeing the teacher.

There were cases where it appeared that wastage and failure rates had risen because of the recent temptation of colleges to teach larger groups without compensatory tutorial back-up in order to raise a polytechnic's student/staff ratio. This bore hard on those students whose abilities barely matched the demands of the course or those with gaps in their earlier study. In some cases it led to low morale.

Subject coverage was usually carefully thought out, well prepared and effectively planned. The style and pace of first degree teaching however tended to be pedestrian and unstimulating, frequently appearing to be more appropriate for technicians than undergraduates. In many classes on fundamental principles there was a tendency to concentrate upon analytical method and numerical examples at the expense of basic engineering and application. To lecturers, the command of a wide range of pedagogical techniques together with the knowledge of alternative teaching strategies were often regarded as being of less importance than a complete command of the subject matter. Usually teachers had kept their subject knowledge very much up to date.

While the statements above represent an overall impression from the whole exercise it must be emphasised that there were many occasions when extremely good teaching was seen. Often this stemmed from a natural ability to generate understanding and to stimulate discussion and enthusiasm, although the pedagogical techniques were no different from those used by others in the department. In other cases where teaching was particularly effective individual lecturers commanded a wide range of teaching techniques which usually included an effective use of prepared teaching aids. The thoughtful use of carefully produced handout sheets and associated overhead projector transparencies usually resulted in some of the most interactive and stimulating learning situations seen.

A major difference in teaching style noted at the postgraduate level, which was rarely apparent at lower levels, was that the technique adopted for management, teaching and pastoral care was one of partnership between staff and mature students. The staff clearly enjoyed teaching in this fashion. However, the assessment of MSc courses did not always sufficiently reflect the partnership style. Rather than relying entirely on examinations and a dissertation, the introduction of an assessment component during the course would help the students to develop their faculty for self evaluation and their technical communication skills. This would require more assignments to be given to students during the courses and would make more effective use of their limited time in college.

The teaching methods and styles used for the TEC-HC courses appeared little different from those previously used for the courses replaced in spite of the totally different philosophy of the new courses. It appeared that little time had been devoted to preparation for teaching the new courses and that perhaps no more would be found in the near future because of other pressures.

Laboratory work — its objectives, its role in the learning experience of the student and teachers' perception of it as an integral part of teaching strategy — varies widely in quality and effectiveness between the engineering departments or sections of a given polytechnic and between polytechnics. Much of what was seen in undergraduate courses failed to stimulate or challenge the students and lacked coherence as a programme of work and with the course as a whole. The lack of resources and suitable accommodation was often claimed, with justification in some cases, to impose constraints on the development of more relevant and motivating laboratory activity. However, some excellent work and innovative approaches were seen taking place in accommodation that was by any standard inadequate and where resources were enhanced through staff initiatives and active contacts with industry. At its best the laboratory course was designed to lead students on from basic exercises in which they were familiarised with instruments, measurement techniques and experimental method, through a series of assignments and mini-projects in which the student's approach to problem solving was developed towards that of the professional engineer. At the other extreme the course comprised a series of traditional practical exercises of the form and of a standard that were the subject of much criticism by the Joint Committees when commenting on the technician courses for which they were then responsible. Most engineering degree and some HND courses now include in the final year a major project requiring the solution of an engineering problem. In first degree courses this normally occupies about a day per week, but in at least one course the whole of the final term is devoted to this work. Considerable emphasis is placed on the project in the overall course assessment. Major challenges are imposed upon the student by the project and upon the staff in the assessment of response and achievement. Generally a high standard was achieved in this work sometimes in spite of the poor preparation given by the preceeding laboratory work.

The amount and the nature of tutorial work varied between courses. In some no special time was allocated for tutorial activity but it was expected that towards the end of a two hour teaching period, time would be set aside for example working and tutorials. Inevitably the lecture encroached into this tutorial time. In other courses special tutorial periods were timetabled during which a member of staff was available to answer queries on any subject contained in the course. As staff rarely had rooms appropriate for the purpose of personal tuition this was virtually non-existent. Although it was usual for full-time and sandwich students to have a personal tutor, regular contact was seldom required or sought.

The tutorial arrangements for HND students tended to be inferior to those for degree students working in the same departments while part-time technician students rarely had personal tutors.

The use of computers is disappointing and insufficient emphasis is placed upon their use in syllabi. Computers are rarely used to back up lecture material and are employed infrequently in laboratory work. Computer aided design and manufacture developments occurring in major industrial concerns are neither reflected in curriculum design nor in engineering teaching. Few students have adequate personal experience of computing techniques.

Each degree course had two or more external examiners. The appointment of these examiners was normally proposed by the polytechnic and approved by the CNAA. Reports from the external examiners to the polytechnic were usually confined to the standard of the final examination questions, the project and laboratory work and the pass rate. Examiners seldom remarked upon the quality of the student intake, course arrangements, teaching, expertise of staff or available resources. In a few cases, external examiners' reports did not appear to reflect certain fundamental difficulties with a course.

3 Resources

3.1 Accommodation

In certain polytechnics inadequacies of accommodation impose quite severe limitations on the effectiveness of teaching practice and course management and these have been referred to earlier. It is exceptional to find engineering departments of polytechnics housed in satisfactory, purpose built accommodation that fully meets present day needs. Departments use a wide variety of permanent and temporary buildings. The permanent accommodation, sometimes dating from the 19th century, has often been designed for purposes other than education. Temporary space is usually found in pre-fabricated huts in varying states of repair.

A number of departments have laboratories, workshops, offices, staff rooms and classrooms dispersed between two or more sites.

The quality of laboratory accommodation is extremely varied. New specialist engineering facilities in some polytechnics provide pleasant, efficient and stimulating environments for the work of students and staff. There are instances where older buildings have been converted satisfactorily and with imagination into excellent laboratories. However, rotting huts with propped up roofs housing valuable electronics equipment are to be seen elsewhere together with dingy and badly lit underground cells containing heavy equipment which, when operating, disturbs the classrooms throughout the buildings above. The growing demands of courses are putting pressure upon the areas available for laboratories and in several departments space is now inadequate. In some departments there is a reluctance to re-allocate laboratory space as needs change between disciplines. There are examples of electrical machines and thermodynamics laboratories in which little used and large and obsolete plant could be replaced by modern technology.

Despite the importance of project work there are seldom separate rooms available for such activity. Projects are usually done in teaching laboratories making time-tabling of these difficult since the project work often occupies each student at least one full day a week. Separate laboratories for postgraduate and research workers are uncommon and where these exist most are small or sub-standard.

Engineering design offices vary enormously. Some are spacious, well lit and properly arranged so as to allow good working space and contain professional quality drawing office furniture and equipment. Others are cramped and overcrowded with drawing equipment and furniture more suitable for schools than higher education. Few design offices have reference areas or dedicated computing equipment and little progress has been made in polytechnics in developing computer aided design facilities.

General computing resources are often inadequate allowing too little student access and providing limited specialist software.

Excepting staff at senior level, few members of engineering staff are provided with separate work rooms and usually two or three share a room. These are often small, lacking professional equipment and, in some cases, even personal desks and filing cabinets. Some staff workrooms are contrived by constructing mezzanine accommodation above workshops and laboratories which, apart from difficulties of access and noise from below, are quite unsuitable for tutorial purposes.

3.2 Equipment

Departments which have been recently rehoused in new buildings usually have been simultaneously reequipped to high standards. Unfortunately, for the majority of departments the equipment situation is far less favourable. Most engineering laboratories had been equipped at or prior to the establishment of the polytechnics and although maintenance has been good much equipment is now obsolete and occasionally unserviceable. This situation coupled with the growth of intakes into engineering courses necessitates prompt equipment replacement and enhancement programmes in order to keep pace with industrial and technological advances. In some cases costs of such programmes will be substantial and to avoid future build up of expense polytechnics and management authorities should institute proper amortization procedures to ensure periodic equipment replacement.

Some departments help themselves by designing and building replacement test rigs when commercial models are found to be unsuitable or too expensive. Some worthy examples were seen of research equipment which had been applied to undergraduate laboratory teaching thereby introducing sophisticated instrumentation and measuring techniques.

Occasionally expensive equipment is duplicated in departments at the same polytechnic when joint usage would reduce initial upkeep and maintenance cost.

3.3 Staff

Areas of responsibility and departmental structures vary between polytechnics. It is usual for between two and four engineering departments to be grouped together within a faculty with each department having responsibility for a single discipline such as mechanical, electrical or civil engineering. There are faculties containing engineering and other technology departments but in other institutions not all engineering departments are in the same faculty. One polytechnic within the survey had a single engineering department organised into three separate schools. Departments have from 20 to 50 staff; a typical department having under its head about 25 academic staff including, possibly, a reader, five or six principal lecturers, each in charge of a particular subject area, 20 senior lecturers or lecturers, about 12 technicians, two or three full-time secretaries and up to four research assistants.

The extent of technician support for departments varies within and between polytechnics. The ratios of technicians to lecturers in some polytechnic departments are twice those in similar departments elsewhere. Where the least technician support is available there are indications of excessive pressure on academic staff and evidence that teaching is adversely affected.

Most departments have their full establishments of academic staff. However in several polytechnics a policy of not replacing retiring staff means that the remaining staff teach up to 10 per cent extra time on part-time contracts. This procedure is adversely affecting research, consultancy and short course activity and one department has had to reduce its intake and course commitments accordingly. The persistence of such policies in some polytechnics is leading to the shedding of part-time and higher technician work and is delaying the introduction of younger staff into departments.

The proportion of graduates among polytechnic engineering lecturers is high. In some departments all staff have graduate qualifications and throughout engineering departments seen more than two-thirds were graduates. Generally those without degrees have Chartered Engineer (C.Eng) status.

Some staff had been in post for 20 years or more. Most had worked in industry for over five years before entering teaching. The main expansion in higher education occurred in the early sixties and many staff who were recruited from industry at that time have remained, often in the same institution. As the opportunities and perhaps incentives for changing jobs have reduced over recent years a static and ageing engineering teaching force has resulted. As a consequence the corporate industrial experience within departments may be a decade or more out of date.

Engineering academic staff generally have more interest in developing technological knowledge than teaching method and strategy. Staff feel that promotion seldom depends upon excellent teaching but rather on organisational and administrative competence and weight of research output. Active and balanced policies for staff development have been effective in some departments but, unfortunately, are now often reduced on financial grounds. Many of the best examples seen called for in-house effort covering both teaching and technological development. Inter-polytechnic specialist groups meeting on a regular basis are also of proven value.

In a few departments the lack of staff development policies is very apparent with newer and younger members of staff given little or no guidance about teaching techniques or paths to personal development through research and consultancy.

About half the total polytechnic staff are currently engaged in some form of research or consultancy work although there are considerable variations between departments and polytechnics. In some polytechnics this work is practically non existent. Some departments have a long tradition of industrial consultancy and research resulting in significant funding and cooperation. The most active and effective research work is achieved when research efforts of a department are focused onto a small number of interrelated and mutually supporting activities. This ensures maximum cooperation from other institutions and industry. Uncoordinated research on an individual basis seldom leads to continuing programmes which attract financial support. Some research groups have established national and international reputations for their research work in particular fields and have attracted very considerable industrial interest and support. Much help has been given by the SERC in supporting such research projects while the SERC/Department of Industry Teaching Company Schemes have proved an increasingly attractive method for developing active technical cooperation with industry. Such close links with industry are very much in the spirit of the 1966 White Paper. *A plan for polytechnics and other colleges* previously referred to.

Nearly all departments have a number of specialist subject groups each headed by a senior member of staff. Usually the groupings reflect main areas of course curriculum but occasionally appear to be more closely related to laboratory responsibility. Subject groups represent the mechanism staff most prefer for developing their subject interests. The more active subject groups have enhanced the subject authority of staff, forged links with industry, universities and other polytechnics and have led to industry and SERC funding for research programmes including the development of Teaching Company Schemes.

Staff duties other than teaching are normally divided between the laboratories, admissions and enrolments, course management and coordination, student tutoring and industrial placements. Usually each course has a course coordinator or director and each class or year has a tutor. In some departments each member of staff acts as personal tutor to a number of students during their time at the college. Course committees meet regularly and consist of the course director, all course tutors and subject teachers and occasionally student representatives. It was refreshing to see deliberate encouragement of younger members of staff to gain administrative and managerial experience by becoming fully involved in the activities outlined above.

Industrial placement of college-based sandwich students occupies an ever increasing amount of academic staff time although this work is often spread between several members of staff. In a moderate sized department it was stated that placement alone fully occupied the equivalent of two full-time members of staff.

4 Summary

1. Restraints in the public sector have denied polytechnics the freedom enjoyed by the universities. These influences have produced a conflict between the original aims of the White Paper and the increasing academic pressures on polytechnics. *(1.1)*

2. Polytechnics cater for about one-third of all engineering degree students in the UK. *(1.2)*

3. A little under half of all students attending polytechnic engineering courses are on sub-degree courses. *(1.3)*

4. Just under one-third of all polytechnic engineering students attend part-time courses. *(1.2)*

5. There is a tenfold variation in engineering degree enrolments between individual polytechnics. *(1.3)*

6. Growing difficulties in obtaining industrial placements for sandwich courses and the scarcity of industrial sponsorships are imposing disproportionate administrative loads and are producing a shift from sandwich to full-time degrees. *(2.2)*

7. The average GCE A-level points score for polytechnic degree course entry lies between 4 and 5 although some are notably higher. *(2.3)*

8. For those students who had not attained a university place, most polytechnic engineering departments provided a second opportunity of obtaining an engineering degree recognised by the Council of Engineering Institutions — and most of those accepted succeeded. *(2.4)*

9. Most HND students first applied for entry to degree courses but did not entirely satisfy the entry requirements. *(2.4)*

10. Where part-time technician courses are available in feeder colleges students prefer to attend these rather than similar courses in polytechnics. *(2.3)*

11. Mixed discipline courses are generally not liked by students, the professions nor industry. *(2.1)*

12. Dip HEs are not well regarded by students. *(2.4)*

13. Part-time degrees should only be provided alongside full-time and/or sandwich degrees in the same discipline. *(2.1)*

14. Enrolment patterns in undergraduate full-time and sandwich courses tend to indicate a north/south polarization. Part-time degree course students may travel up to 100 miles each week to attend a polytechnic. Part-time technician students normally come from a catchment extending from the local to sub-regional areas. *(2.3)*

15. The teaching was always dedicated — occasionally inspired but often pedestrian in style and pace. *(2.6)*

16. Growth in enrolments and pressures to raise student staff ratios have led to overcrowding and adversely affected the teaching. *(2.6)*

17. There has been little change in teaching methods and styles as a result of the introduction of TEC courses. *(2.6)*

18. Students were extremely well motivated and were particularly appreciative of staff efforts on their behalf. *(2.4)*

19. Laboratory work is often inappropriate as a support for teaching strategy and inappropriate as a lead into project work. *(2.6)*

20. General computing facilities are often inadequate which may partially explain the insufficient emphasis on their use. *(3.1, 2.5)*

21. Accommodation varied from the rare excellent purpose built block to the appalling. In most departments accommodation was inadequate in some respect. *(3.1)*

22. Some considerable efforts have been made to keep equipment up-to-date but a great deal of plant is rapidly becoming obsolete or inappropriate for the teaching of present day engineering. The capital injection required to make good this deficiency and thereafter sustain the standard required is now so daunting as to appear prohibitive to some LEAs. *(3.2)*

23. As financial restrictions continue to limit both teaching and material resources there is a possibility that some polytechnic engineering departments will decide to concentrate their efforts upon undergraduate work and will abandon part-time and technician work to other colleges already competing at this level. *(3.3)*

24. The ratios of technicians to lecturers in some polytechnic departments are twice those in similar departments elsewhere. *(3.3)*

25. Staff are both academically well qualified and industrially experienced but in a number of departments, since there have been few new appointments during the past 15 years, there is now a lack of recent first-hand industrial experience. *(3.3)*

26. About half the total polytechnic engineering staff are currently engaged in some form of research or consultancy work although there are considerable variations between departments and polytechnics; in some polytechnics this work is practically non-existent. Some individual members of staff or groups have achieved international reputations in particular fields of research. *(3.3)*

Appendix

Titles and modes of first degrees and diplomas in the higher education inspected

Electrical engineering		No of courses
Electrical engineering	BSc only 4 year PT	1
Electrical engineering	BSc Hons only 4 year SW	1
Electrical engineering	BSc/BSc Hons 4 year SW	1
Electronic engineering	BSc/BSc Hons 4 year SW	1
Electronic engineering	BSc Hons only 4 year SW	1
Electronic engineering	BSc/BSc Hons 4 year PT	1
Electrical and electronic engineering	BSc/BSc Hons 3 year FT	1
Electrical and electronic engineering	BSc/BSc Hons 4 year SW	2
Electrical and electronic engineering	BSc only	1
Electrical and electronic engineering	BSc Hons only 4 year SW	1
Electrical and electronic engineering	BSc Hons only 4 year SW	1
Electrical and electronic engineering	BSc Hons only 4 year SW	1
		Total 13
Electronic engineering	Dip HE 2 year FT	1

General and other engineering

Engineering	BSc/BSc Hons 3 year FT	1
	BSc only 4 year PT	1
Engineering product design	BSc Hons only 4 year SW	1
Engineering technology	BSc/BSc Hons 3 year FT	1
Engineering with business studies	BSc/BSc Hons 4 year SW	1
Technology	BSc only 4 year SW	1
Technology with industrial studies	BSc only 4 year SW	1
	Total	7

Technology	Dip HE 2 year FT	1

Mechanical engineering

Mechanical engineering	BSc/BSc Hons 3 year FT	2
Mechanical engineering	BSc/BSc Hons 4 year SW	2
Mechanical engineering	BSc only 4 year SW	1
Mechanical engineering	BSc only 4 year PT	4
	Total	9

Production engineering

Production engineering	BSc only 4 year PT	1
	Total	1

Table 1 *Comparative engineering degree course enrolments for 1981—82 in universities and polytechnics in the UK*
Total course enrolments

Level	Higher degrees and PG courses		First degree courses		All engineering degree courses						Per cent engineering higher and PG of all degrees		per cent polytechnic share of all Engineering degree enrolments
					University		Polytechnic		Total				
Subject Group	Univ	Poly	Univ	Poly	All degrees	Per cent univ eng^r	All degrees	Per cent poly eng^r	All degrees	Per cent all eng^r	Univ	Poly	
Aeronautical engineering	79	—	1,184	57	1,263	3.1	57	0.3	1,320	2.3	6.25	0	4.3
Chemical engineering	497	—	3,073	481	3,570	8.8	481	2.8	4,051	7.1	13.9	0	11.9
Civil engineering	973	137	6,128	3,340	7,101	17.6	3,477	20.5	10,578	18.4	13.7	3.9	32.9
Electrical engineering	1,350	76	9,156	5,211	10,506	26.0	5,287	31.1	15,793	27.5	12.8	1.4	33.5
Mechanical Engineering	773	71	6,444	3,447	7,217	17.9	3,518	20.7	10,735	18.7	10.7	2.0	32.8
Production engineering	147	158	764	808	911	2.3	966	5.7	1,877	3.3	16.1	16.4	51.5
General and other engineering	1,727	133	8,058	3,078	9,785	24.3	3,211	18.9	12,996	22.7	17.6	4.1	24.7
All groups	5,546	575	34,807	16,422	40,353	100.0	16,997	100.0	57,350	100.0	13.7	3.4	29.6

Derived from UGC, DES and CNAA statistics for 1981/82

Table 2 *Polytechnic engineering enrolments (October 1981) — national enrolments by subject group, level and mode of study*

Subject group	Levels: Higher degree/PG — Modes: Full-time and sandwich	Part-time	All	First degree (inc Dip HE) — Full-time and sandwich	Part-time	All	Sub-degree — Full-time and sandwich	Part-time	All	Student numbers (all levels and modes)	Subject numbers % of overall total
Aeronautical engineering	—	—	—	57	—	57	—	9	9	66	0.2
Chemical engineering	—	—	—	462	19	481	110	55	165	646	2.6
Civil engineering	17	120	137	2,725	172	2,897	831	961	1,792	4,826	17.6
Electrical engineering	8	68	76	4,069	393	4,462	2,265	2,148	4,413	8,951	32.6
Fuel technology	17	38	55	—	—	—	—	—	—	55	0.2
General and other engineering	16	90	106	2,212 (27)	405	2,617 (27)	311	2,419	2,730	5,453	19.9
Marine engineering	—	—	—	—	—	—	64	—	64	64	0.2
Mechanical engineering	23	33	56	2,814	306	3,120	1,835	585	2,420	5,596	20.4
Naval architecture and shipbuilding	—	—	—	—	—	—	71	19	90	90	0.3
Production engineering	2	156	158	627	74	701	225	563	788	1,647	6.0
Totals	83	505	588	12,966	1,396	14,335	5,712	6,759	12,471	27,394	—
% of overall total	0.3	1.8	2.1	47.4	5.0	52.4	20.8	24.7	45.5	—	100

Table 3 *Polytechnic engineering enrolments (October 1981)—overall degree, postgraduate and sub-degree enrolments of polytechnics in England and Wales*

Polytechnic	Enrolments (all modes)		Degree and PG (%)	Level	Higher degree/PG			First degree (inc DipHE)			Sub-degree		
	Degree	All PG levels		Mode	Full-time & sandwich	Part-time	All	Full-time & sandwich	Part-time	All	Full-time & sandwich	Part-time	All
Coventry	1,176	1,650	71		6	89	95	1,081	—	1,081	234	240	474
Portsmouth	1,078	1,393	77		26	29	55	993	30	1,023	285	30	315
S Bank	910	1,580	58		9	13	22	638	250	888	339	331	670
Trent	877	1,442	61		—	9	9	787	81	868	312	253	565
Hatfield	818	1,191	69		15	32	47	771	—	771	348	25	373
Kingston	754	889	85		—	43	43	594	117	711	135	—	135
Sheffield	641	1,404	46		6	19	25	523	94	617	248	515	763
Brighton	634	733	86		—	1	1	625	8	633	—	99	99
Plymouth	613	886	69		—	—	—	613	—	613	206	67	273
Wales	612	1,000	61		—	5	5	605	2	607	241	147	388
Liverpool	607	1,113	55		10	2	12	512	83	595	354	152	506
Middlesex	595	1,035	57		—	82	82	452	61	513	197	243	440
Thames	552	656	84		3	47	50	483	19	502	67	37	104
Manchester	511	799	64		—	—	—	386	125	511	199	89	288
NE London	456	894	51		2	82	84	284	88	372	192	246	438
Teeside	454	1,015	45		—	12	12	442	—	442	51	510	561

Notes (1) Polytechnics listed in order of the size of their total degree and PG enrolment
(2) Table 2 covers all subject groups listed in Table I.
(3) An average university possibly has around 900 engineering enrolments.

Table 3 (*continued*)

Polytechnic	Enrolments (all modes)		Degree and PG (%)	Level: Higher degree/PG			First degree (inc DipHE)			Sub-degree		
	Degree	All PG levels		Mode: Full-time & sandwich	Part-time	All	Full-time & sandwich	Part-time	All	Full-time & sandwich	Part-time	All
Sunderland	449	673	67	—	15	15	369	65	434	173	51	224
Central London	412	478	86	—	—	—	412	—	412	64	14	78
Newcastle	389	827	47	—	24	24	365	—	365	177	261	438
Huddersfield	340	719	47	—	—	—	340	—	340	230	149	379
Leeds	291	879	33	—	—	—	240	51	291	288	300	588
Oxford	275	770	36	—	—	—	236	39	275	148	347	495
N Staffs	267	752	36	—	—	—	267	—	267	168	317	485
Leicester	247	861	32	—	—	—	243 (27)	4	247 (27)	176	411	587
Bristol	177	713	25	—	—	—	69	108	177	210	326	536
North London	166	264	63	—	—	—	166	—	166	74	24	98
Preston	163	712	23	—	—	—	136	27	163	231	318	549
Wolverhampton	137	465	29	—	—	—	119	18	137	28	300	328
Birmingham	99	999	10	—	—	—	—	99	99	238	662	900
City of London	—	—	—	—	—	—	—	—	—	—	—	—
Average enrolments	498	913	55	3	17	20	432	46	478	190	225	415

Notes (1) Polytechnics listed in order of the size of their total degree and PG enrolment
(2) Table 2 covers all subject groups listed in Table 1.
(3) An average university possibly has around 900 engineering enrolments.

Table 4 *Principal subject group enrolments at each polytechnic by level and mode, with first degree and higher degree postgraduate combined*

Subject size / Polytechnic	Chemical			Civil				Electrical					General					Mechanical					Production			
	1–50	51–100	101–200	1–50	51–100	101–200	201–300	1–50	51–100	101–200	201–300	301–400	1–50	51–100	101–200	201–300	301–400	1–50	51–100	101–200	201–300	301–400	1–50	51–100	101–200	201–300
Coventry				s		D		s	S	D					s		D			S	D			S		D
Portsmouth					S		D	s		S		D		D				d		S		D				
South Bank	Sds		D	S	Ds				ds	Ds			S	d	s	D		D	dS							
Trent				dSs		D				Ss	D		S	ds		D			D	S			S	D		
Hatfield					S	D			S	D			s		D					S	D		S			
Kingston					d	D				DS						D		DS								
Sheffield					Ss	D			S	Ds				d		Ds			S				D			
Brighton				ds		D		ds			D		s					d			D					
Plymouth						D			s	S		D							S	D						
Wales	dS		D	Ss		D		s		DS			s						S	D						
Liverpool				Ss		D		d	s	S	D		dSs		D			d		S			s			
Middlesex				Ss		D			d	SsD			Ds					s	S	D			s			
Thames					S	D		s	D				s		D			d		D			d			
Manchester	s							ds	S	D			Dds					s		DS			d			
NE London	D			S	ds	D			DSs				d	S	s			DSs					S			
Teeside		Ss	D			D				s					s			s	D					D	s	
Sunderland								s	S	D			s	d				S			D					
Central London						D		s		D									DS				D			

Table 4 (*continued*)

Subject size	Chemical		Civil		Electrical				General				Mechanical				Production		
Polytechnic	1– 50	51– 100	1– 50	51– 100	1– 50	51– 100	101– 200	201– 300	1– 50	51– 100	101– 200	201– 300	1– 50	51– 100	101– 200	201– 300	1– 50	51– 100	101– 200
Newcastle		s		s		Ss	D		S	s				S	D				
Huddersfield					s		DS		S		s			S	D		S	D	
Leeds				Ss		ds	DS				s		s	S					D
Oxford			s	DS	d	s				s	D			S	s				s
N Staffs			s			S	Ds			s			s	S	D		s		
Leicester						S	Ds				D	s	d	S					
Bristol			s		d	S	s			DS	s		s	dS					
North London						s	S	D											
Preston			s			D	Ss		S	s			Dsd	S			dS	s	
Wolverhampton	S	s				s			d	s				s	D				
Birmingham			S	s	d	S		s	S			s	S	d		s	S		s
City of London																			

Key:

Full time and sandwich degree	D
Part-time degree	d
Full-time and sandwich sub-degree	S
Part-time sub-degree	s

Printed in the UK for HMSO Dd. 737405 C10 2/84